Advanced Computer Aided Design, PPU080

Project Work Outline for the Academic Year 2020/2021

1. Task

The task of the project work is to model a wheel excavator in CATIA V5 and to perform geometry assurance on the relation between the door and the body of the cab. The detail level and proportions of the excavator shall be realistic for a toy excavator; examples will be available at the lectures.

The size of the excavator, however, should be **REAL SIZE**. On the internet, there are numerous pictures of excavators that can be studied.

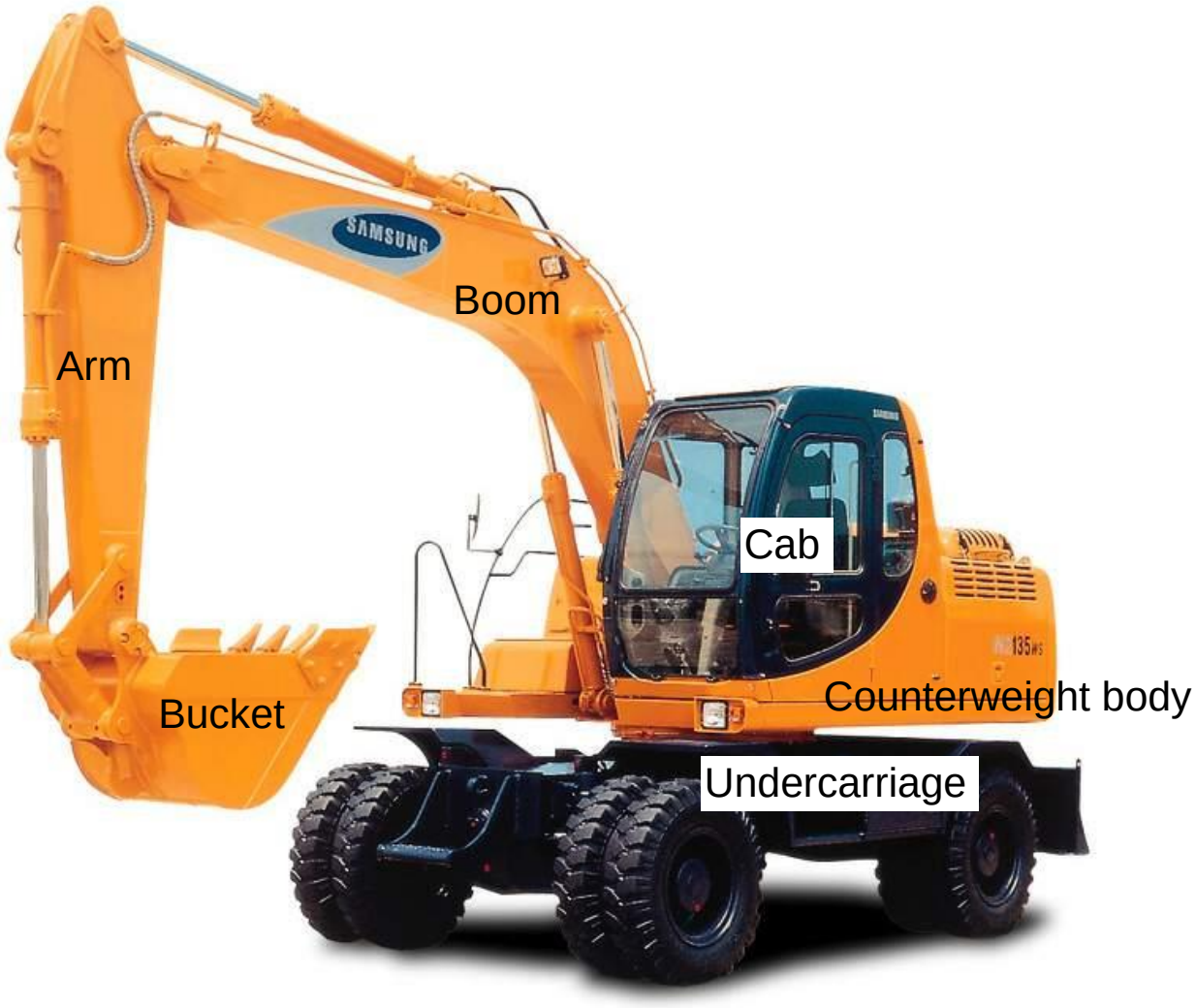
The mandatory parts of the project shall be done in groups of two. Please, avoid groups of one. You shall register your group in Canvas. The extra tasks should be done individually.

All tasks should be approved, in person, by one of the teachers. Before you start modelling, spend some time planning your model and your work.

We encourage you to discuss with your fellow students before asking a teacher.

All finished parts should be solid, also when they are modelled with surface modelling.

As soon as one task is finished, get it approved. Max three tasks will be approved at a time.



2. Mandatory Parts of the Excavator

Part	Surface modelling
Cab	Required
Bucket	Required
Counterweight body	Required
Undercarriage	Not Required
Wheels	Not Recommended
Arm and boom	Not Required
Hydraulic cylinders for arm and boom	Not Required
Rubber sealing	Not Required

- All the parts shall be correctly constrained with the correct degrees of freedom.
- Sketches in all tasks must be fully constrained, unless specified otherwise.
- When surface modeling is mandatory, it is meant to model something that is either not possible to model without surface modeling or it requires more features in the modeling if surface modeling is not used. For inspiration, see Catia Surface Exercise 1: Grip.

3. Mandatory Tasks

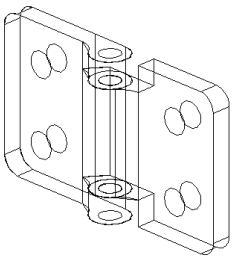
Cab

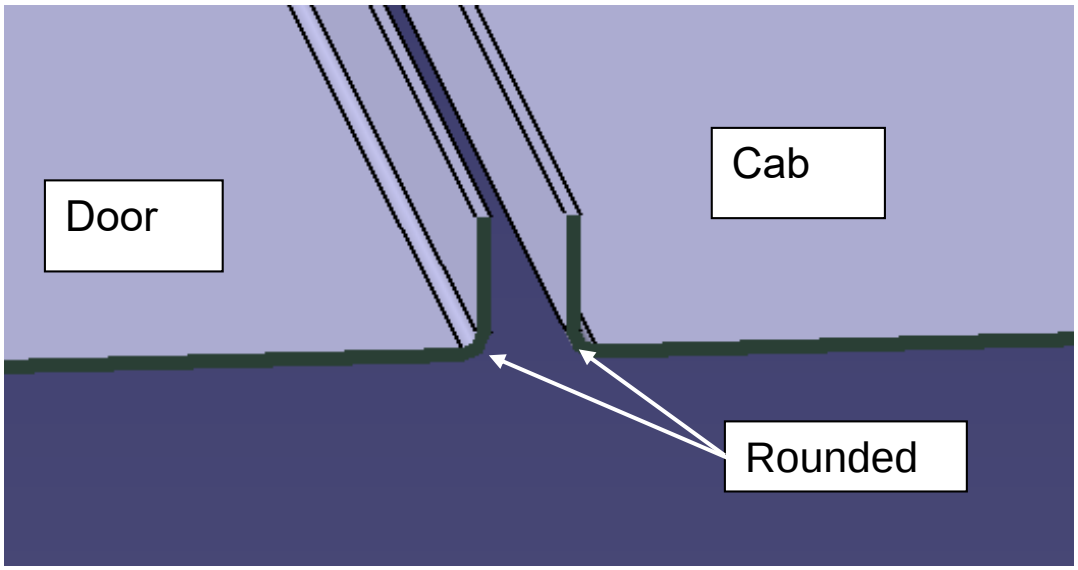
NOTE! Start with this model, it should be approved before the others.

The shape of the cab is created by the industrial design department in Alias. The task is to import this shape in Catia and create a detailed design.

For this part, emphasis will be put on structured surface modeling.

- All wireframe geometry (points, curves, sketches) should be placed in a *Geometrical Set*
- All surface geometry should be placed in a separate *Geometrical Sets*
- The imported shape of the cab should be divided into:
    - Separate windows
    - Separate door with split-line between the door and the body of the cab
    - The rest of the cab
- These three groups should be converted into solids in separate *Part Bodies* (or separate parts).
- The sheet thickness shall be 2 mm.
- Create the solids in the workbench *Part Design,* and command *Thick Surface*.
- Two separately modeled hinges shall be included (can be modeled with solids)
- Other, eventual, accessories, e.g. handles can also be modeled with solids.





- The interface between the cab and the door should have flanges, see figure above for a cross section of a split-line between the door and the cab.

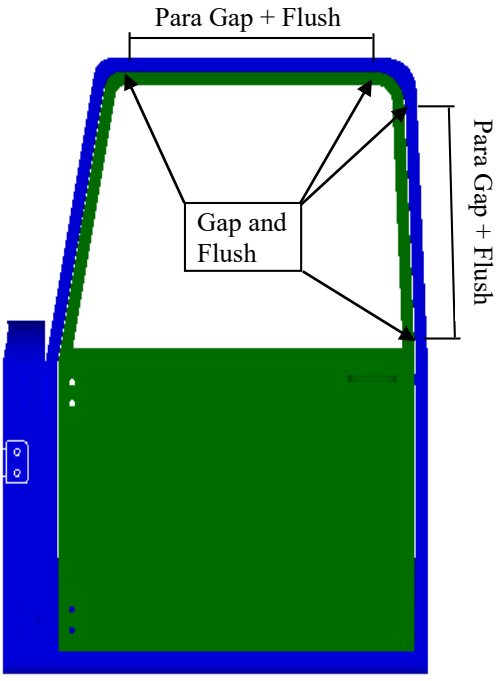
Geometry Assurance

NOTE! Start with this model, it should be approved before the others.

Both halves of the hinges should be exported to one VRML-file (one for each hinge)

The relation between the door and the body of the cab should be analyzed and documented in RD&T. See exercises and documentation about RD&T in Canvas.

- The model shall consist of a subassembly with the hinges mounted on the door
- Define how the door positioned relative to the cab, it shall be positioned by the hinges
- Define the necessary positioning systems and subassemblies.
- Define measures for two of the relations around the door, gap, flush and parallelism for both gap and flush, i.e.,
    - 4 Gap measure
    - 4 Flush measures
    - 4 Parallelism measures
- Define tolerances for all target location points and measure points. (Google for typical tolerances for sheet metal parts)
- Define two requirements, for the two relations, use the defined measures



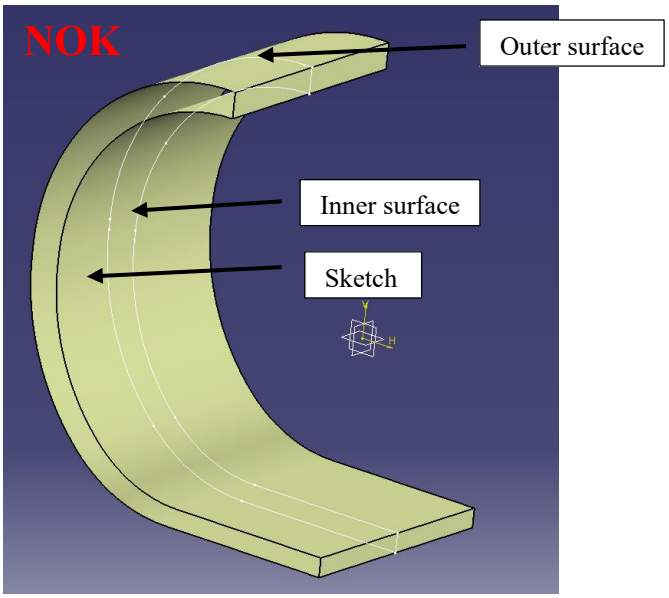
The following documents shall be created:

- Master system layout
- Requirement drawing
- Calculation pages for both requirements

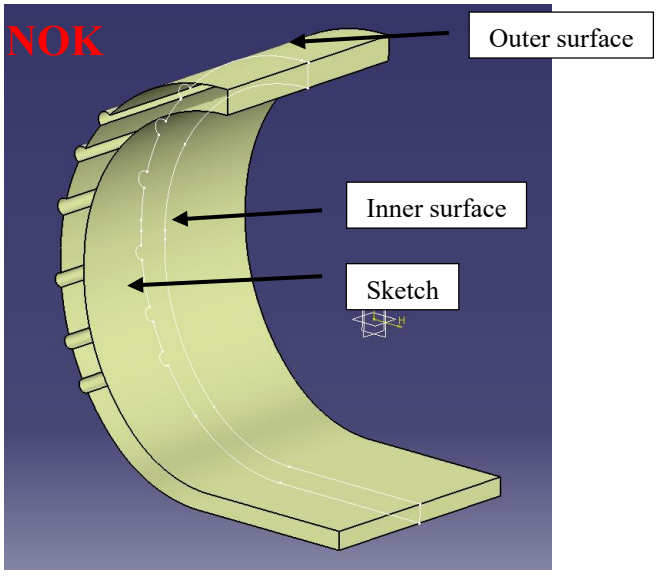
For the approval you should be able to discuss the results, are they good or bad, how can they be approved etc.

Bucket

- This geometry can be rather complicated so think about a modelling strategy before starting the work.
- Shall be done with surface modeling.
- Should be made from one inner and one outer surface with grooves (make it to a solid using Close Surface).
- The inner surfaces and outer surfaces of the bucket should be modelled using separate sketches and not in one single sketch. (see figure below)



- The grooves on the outer surface should not be within the same sketch. They must be made as a separate feature and then attached to the outer surface using "Operations" commands (split, trim, join etc.) – see figure below.
- The grooves on the outer surface should be on the curved area of the outer surface and not on the flat surface of the outer surface - see below figure

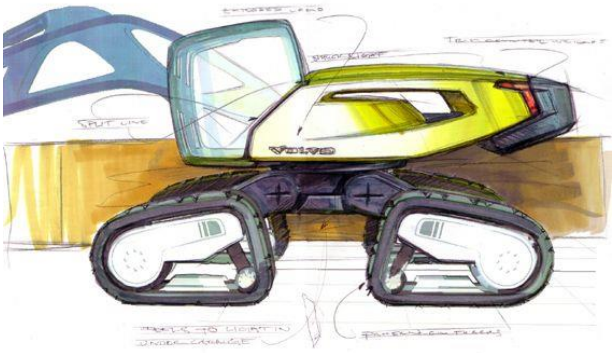


- Create the solids in the workbench *Part Design*.

- The teeth and attachment features shall be made as separate bodies (but with surface modelling).
- Advanced geometry with no sharp corners.
- The bucket should be in **REAL SIZE** (not toy size).
- Based on the methodology in exercise 1 (oversized surfaces etc)


Counterweight body

- Shall have realistically detailed geometry
- Shall be done with complex surfaces using surface modeling.
- Create the solids in the workbench *Part Design*.



It shall have a bottom plate with a thickness of 100 mm on which the cab and boom shall be attached, see sketch below. The bottom plate should be made as a separate solid part.

- The bottom plate can be done with solid modelling.

- Width of the body: 2500 mm
- A pin with diameter 500 mm that shall fit the hole in the undercarriage
- Make sure that the cab fits nicely to the counterweight body (the shape of the cab is available in Canvas).
- You are encouraged to make a futuristic design of the counter weight body, not a simple box.
- Modelling of the counter weight body using just one command such as multi-sections surface must be avoided. You are encouraged to use combination of “Surfaces”(extrude, sweep, fill, blend, multi-section etc.) and “Operations” (join, split, trim etc.)
- Add some realistic details, at least two of: exhaust pipe, steps, ventilation grills, railings etc.

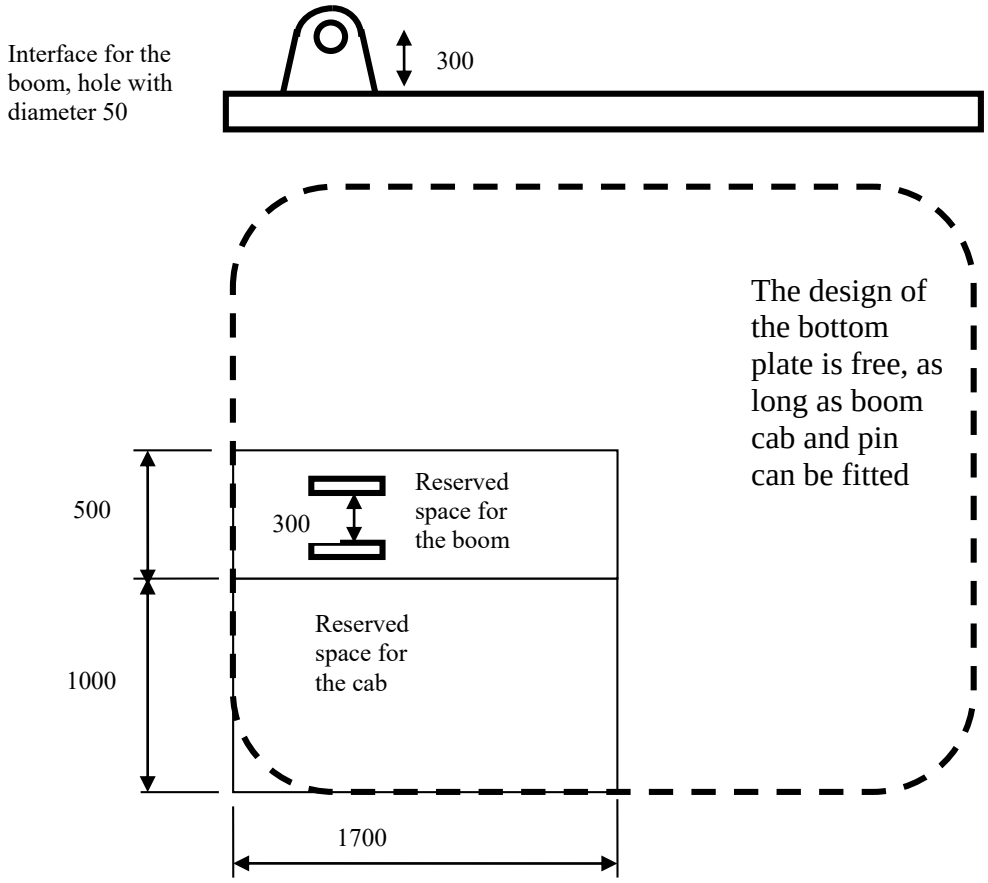


Figure 1 Schematic sketch of bottom plate

Undercarriage

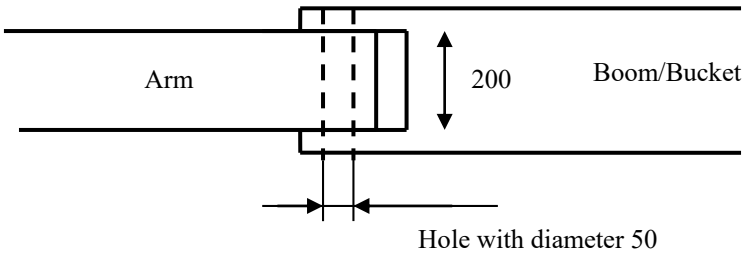
- The actual undercarriage shall be realistically modeled.
- The wheel base (check the definition) shall be 2600 mm
- The wheels contain a standard interface with a number of holes such that the wheels can be attached with screws collected from the standard library in CATIA.
- Use *Pattern* to create the holes in the hub and wheel.
- The interface to the counterweight body is a circular platform with diameter 1000 mm, at the center of the platform there is a hole with diameter 500 mm

Wheels

- Solid modelling is recommended
- The tire and the rim should be modeled as two separate parts (not Part Bodies) in one assembly (Product).
- The rims shall be realistically modeled
- Realistic tires with tread
- The outer diameter of the wheels shall be fixed with diameter 800 mm, and the diameter of the rims shall be parameterized and able to vary between 500 and 600 mm.
- The parameterization should be controlled by one parameter.
- The interface to the undercarriage is described above.

Arm and boom

- Arm and boom, both hollow (rectangular tube)
- Attachment features between boom and arm and arm and bucket:



Constrained Assembly with Hydraulic cylinders

Hydraulic cylinders:

- Can have rather simple geometry
- Realistic interfaces to the excavator
- The complete cylinder should be modelled as a subassembly.
- You will have to use *Flexible* subassembly in order to constrain the cylinders to the excavator

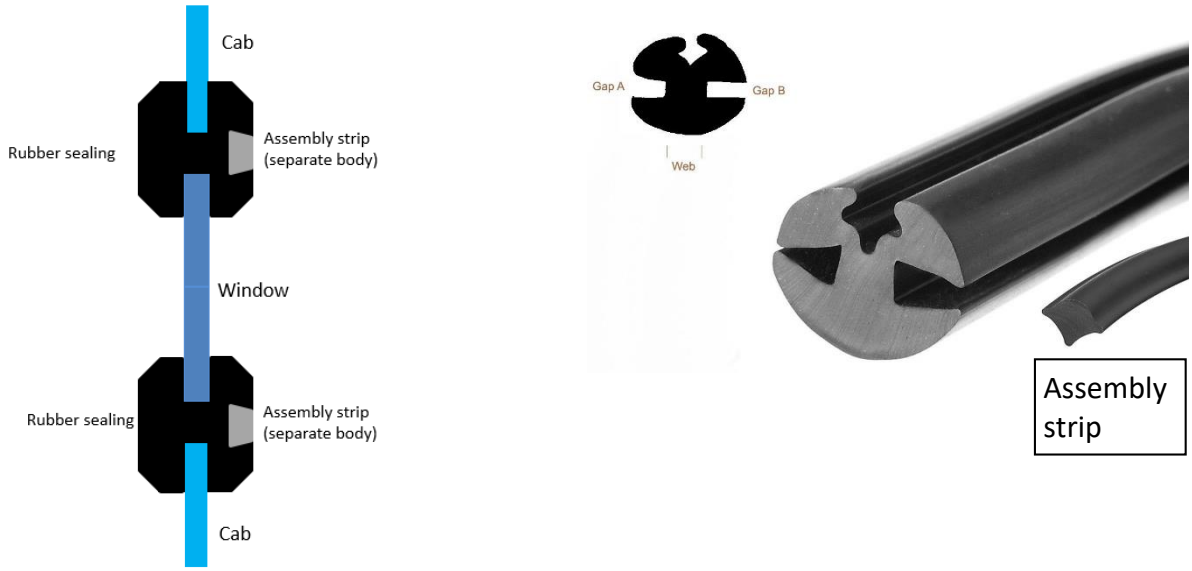
Assembly:

- Undercarriage fixed.
- All joints should be correctly constrained (have the correct degrees of freedom).
- Door does not have to open.
- Screws for the wheels, reuse pattern.

Rubber sealing

The front window should be mounted to the cab with a rubber sealing. (not the other windows). The task is to model this sealing for the front window. See the figure below for an example of how this sealing can be designed. The assembly strip (also of rubber) is needed in order to be able to assemble the window, it is assembled after the sealing and the window is in place.

- The design of the sealing is rater free but should be realistic.
- The assembly strip should be modeled as a separate body
- There has to be a gap between the cab and the window.
- The assembly strip should face inside the cab
- Minor clashes between the parts are allowed since the assembly strip is elastic.



4. Project Grade

Approve of the mandatory parts of the excavator, the geometry assurance task and the PDM task will result in grade 3.0 for the project. The project grade can be increased (up to 6.0) by performing extra tasks which have to be approved by the supervisors. These extra tasks will be presented in a separate PM.

Example 1: 42 points on the exam gives grade 5.2,
this together with a project grade of 4.3
gives a total grade of (5.2+4.3)/2 = 4.75
which is rounded downwards to the final grade 4.

Example 2: 20 points on the exam gives grade 3.0,
this together with a project grade of 5.3
gives a total grade of (3.0+5.3)/2 = 4.15
which is rounded downwards to the final grade 4.

Note that one of the purposes of the extra tasks is that the student should train in using available information (e.g. Catia help) to learn how to use new functionality in a CAD-system. Therefore, less help than for the mandatory tasks can be expected from the teachers.

5. Approval of Tasks

- Each task (mandatory and extra) should be approved by a teacher
- The mandatory parts should be approved for each group of two
- The extra tasks should be approved individually for each student
- Close to deadlines there might be long waiting lists for getting tasks approved
- Therefore, as soon as you have finished a task, ask to get it approved.
- For approval of each task, students are required to:
    - Have the models ready to be shown (loaded in Catia).
    - Briefly explain the strategy used to model the task
    - Make sure that all requirements are fulfilled before showing a task to a teacher (see PM)
- Since the approval will be made via Zoom, it is strongly recommended to use a personal laptop with camera and microphone capbilities. If that is not possible, and you have to use the student computers, it will be much more complicated.
- **NOTE!** Moving, or using Save As, on a Catia assembly might break the links to included parts and make the model corrupt. Please refere to the Appendix for instructions.

6. Time Schedule

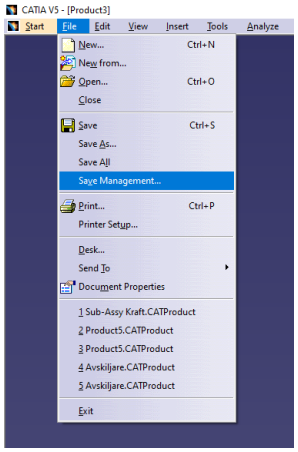
- 25/9 Approval of the Cab and Geometry Assurance
- 16/10 Approval of the rest of the mandatory parts of the project
- 23/10 Last chance for approval of extra tasks

7. Changes from last year

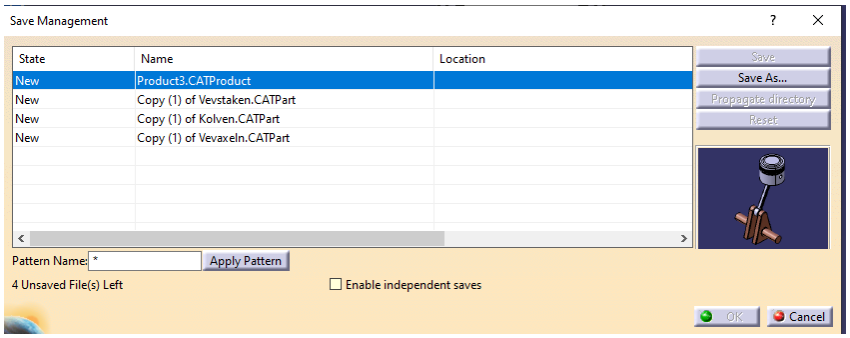
- Approval online in Zoom.

APPENDIX

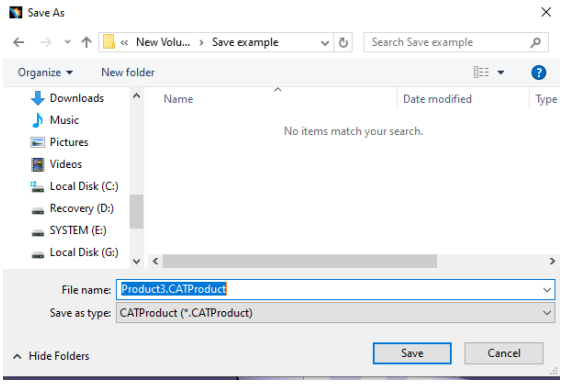
- Go to > “File” > “Save Management”



- Select the Assembly file in the format > “XXXXXX.CATProduct” and “Save As”



- Choose the location to save



- Select “Propagate Directory”. Doing so will save all the parts belonging to the assembly in the same location